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Preparation and Characterization of Aluminium-Pillared Inter Layer Clay with 20% Ferric Chloride ($FeCl_2$).

Kabir Mahmud Garba, Prof. A. B. Muhammad

Department of Pure and Applied Chemistry, Faculty of Science, Usmanu Danfodiyo University, Sokoto

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Abstract: Mix Aluminium-Iron (80:20) pillared clay was prepared through pillarization method, after purification using standard method to reduce the amount of Quartz present. The procedures involved were purification, preparation of the pillaring solution, hydration of parent clay, calcinations, intercalation of Aluninium and Iron metal oxides as pillars. BET N_2 absorption technique was employed in order to determine the surface area, pore volume and micropore volume which was found to be 6.929 (Å) 139.669 m^2/g, 0.057 cc/g, 0.074 cc/g, respectively. The XRD analysis was also carried out to determine the minerals obtainable in the sample, which montmorillonite (Na,Mg and AlO_3) and Quartz peak were observed at a relative intensity of 49.15 and 100% with d-spacing of 0.3073(Å) and 0.1023(Å) respectively.

I. Introduction and Literature Review

1.0 Introduction

Indonesia is one of country in the world which recorded a huge potential in mining clay. Reviews of clay, clay minerals and their application in industry are widely reported in national and international publications. Clay is a clay mineral in accordance with the nomenclature given by the *Association Internationale Pour l'etude des Argiles* (AIPEA) in 2006. Clay minerals include some minerals such as bentonite and kaolinite have different molecular structures and are used in different purposes. These materials can be found in the nature from different sources and can also be synthesized in the laboratory. (Dharvsi and Morsali,2011)

1.1 Bentonite Clay

Bentonite is generated from the alteration of volcanic ash, consisting predominantly of smectite minerals, usually montmorillonite. Besidesmectite, bentonite contains a variety of accessory minerals, including quartz, calcite, feldspar, mica, and illite. The presence of such minerals reduce the value of bentonite. So that most of the low-grade bentonite Is not suitable for industrial applications, such as water purification (Li *et al*.,2010).

Bentonite is a clay-based material derived from the alteration, over geological time periods, of glassy material emitted from volcanoes - tuff and ash. It can also be derived from alteration of silica bearing rocks such as granite and basalt. The environmental requirements for the formation of the clay, that is the main component found in bentonite, are only approximately known. Different climatic and hydrological environments together with the different ages and depths of occurrence produce subtle variations in this clay. (Bergaya*et al*.,2006).

Bentonite is an aluminum phyllosilicate generated frequently from the alteration of volcanic ash, consisting predominantly of smectite minerals, mostly montmorillonite (MMT) (80-90 % by weight). Due to its special properties, bentonite is a versatile material for geotechnical engineering and as well as their demand for different industrialapplications (James *et al*., 2008).

Bentonite is the commercial name of whole range of natural clays with a high water absorption capacity causing it to expand and swell. Bentonite may contain a variety of accessory minerals in addition to montimorollonite. These may include lesser amount of other clay minerals such as kaolin, mica, illite, as well as non clay minerals like guartz, feldspar, calcite, and gypsum. Bentonite quality, and consequently Its application depend on whether it contains any of these other minerals (Bulut and Chimeddorj, 2009).

1.2 Formation of Bentonite

Bentonite is a mineral derived from the alternative of glassy material emitted from volcanoe (tuff or ash) or from the alteration of silica bearing rocks such as granite and basalt. Bentonite only forms in the presence of water. Depending on the nature of formation, Bentonite can have a variety accessory minerals in addition to its constituent mineral montomorillorite. These minerals may include altapulqite, kaolin, mica and illite as well as minerals like quartz, fieldspar,calcite and gypsum. The presence of these minerals may affect the value of a deposit, (celik,2010).

1.3 Types of Bentonite

There are two most widely used Bentonites which are recognized and the uses of each depend on specific physical properties.

1.**Sodium Bentonite;** (swelling Bentonite)

Sodium bentonite is the type of swelling clay. It has single water layer particles which contains Na+ as the exchangeable ion. And it's characterized by expansion up to 15 times of original volume when immersed in water.

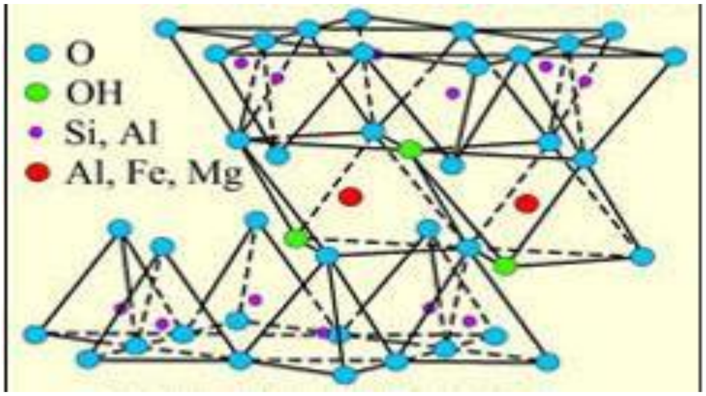
2.**Calcium bentonite;** (Non-swelling bentonite)

Calcium bentonite is the non-swelling clay. It has a double water layer with Ca2+ as the

Exchangeable ion. And its characterized by the adsorption property but do not show expansion when mixed with water. It has the ability to disperse in water and has very wide spread in nature (Bergaya and Theng, 2006).

1.4 Bentonite Structure

While sharing a common elementary structure the various types of bentonite are very Different with regard to their chemical composite, as well as to the physical state of their Constituent which account for bentonite different properties and determine its various technological application. Montomorillonite is an aggragate of lamellar platelet, packed together by electrochemical forces and containing interposition water. Each platelet consists of three sandwich arranged layers: a central octahedral Alumina (Al_2O_3) layer, and two tetrahydral silica (SiO_2) layer.



The silicon ion and the aluminium ion often undergoes amorphous substitution by lower valence metal such as magnesium and iron.In turn, these substitution lead to a charge imbalance, compensated by exchangeable cations, in particular calcium (Ca^{2+}), magnesium (Mg^{2+}) and sodium (Na^{+}) ions, together with water molecules bonded together by ion-dipole forces. These ions, with no more place inside the reticular structure, migrate to the external silica layer and are the main cause of hydration in the crystal lattice. (Bulut*et al.*, 2009)

1.5 Properties of Bentonite

The most important properties of bentonite for which it is employed in many different

Industries are as follows:

i. Water absorption and swelling

A fundamental property of bentonites have the same absorption capacity. Its level of hydration and swelling depends on the type of exchangeable ions, contained with different hydrophilic and solvating power. Swelling is mainly due to two factors

1)water absorption of platelet surface, and 2) osmotic repulsive force, forcing platelet to detch and open like a “stack of card”, Sodium bentonite with sodium cation prevalence (Na^{+}) allow water to penetrate through the platelet forcing them apart, thus leading them to swell conversely. Calcium bentonite with calcium cation prevalence (Ca^{2+}). while getting hydrated in much the same way due to its strong positive charge has lower absorption properties not permitting water to penetrate through the platelets, in these latter case, platelet flake off rather than swell (Celik, 2010).

ii. Viscosity and thixotropy of aqueous suspension

When bentonite is dispersed in water, highly stable colloidal suspensions are formed with high viscosity and thixotropy at high enough concentration these suspension begin to take on the characteristic of a gel suspension formed when water molecules penetrate into platelet inter layers. Here hydrogen bridge bonds are formed by the hydrogen atoms contained in the water molecules platelets becomes isolated from each other, while bonded through interposition water. Jelifies conversely, under mechanical stress these bonds partially break thus allowing platelets to move more freely. Viscosity under these condition is lower than at rest. This reversible sol-gel-sol process is known as thixotropy. These properties shown by bentonite aqueous suspension are mainly exploited in drilling slurries (Celik, 2010).

iii. Colloidal and water proofing properties.

When water is absorbed by bentonite a semi solid gel formed with strong hydrostatic pressure resistance. A montmorillonite platelet can be figured out as a thin packet of negatively charged layer. Due to their negative charge, they repel each other while letting water through. In this way while the packet swells as table shell is formed around the platelet. When saturated, this shell will repel water even under pressure for all these properties bentonite is employed in ponds and docks to seal off soil in filtration and line the base of land fill (Bulut*et al*., 2009).

iv. Binding property

This bentonite property is mainly exploited to produce green moldings and in this application bentonite with a suitable moisture contact covers quartzs and grams and acts as a connective tissue to the entire mass under this homogenous coating, even at maximum compression water remain in a highly "rigid" state binding the sand grains and lending maximum resistance to the sand mould. Bentonite verification temperature is higher than other clays. Therefore, when used as an additive, it makes green sand more durable and in particular more resistance (Bulut*et al*.,2010).

v. Surface properties (corgulation-absorption-adsorption)

Bentonite absorption-adsorption properties are determined by the high specific

Surface and free charges present on each, corgulation occurs through the adsorption of ions of opposite charge to that of colloidal particles (Simic and Uhlik, 2006).

1.6 Application of Bentonite Clay

Water treatment

Due to its ion exchanger flocculation and sedimentation properties bentonite is used in environmental protection for water clarification and as an aid to polyelectrolites and inorganic flocculants, (Simic*et al*., 2006)

Agriculture

Bentonite is used as an ion exchanger for soil improvement and conditioning. It is also used for garding in soil compounds and mixture to absorb humidity and as a carrier for various herbicide and pesticides, (Simic*et al*., 2006)

Ceramics

Bentonite is used to enhance ceramic paste plasticity and as an anti settling agent in ceramic enamels (Simic*et al*., 2006)

Paper

Bentonite is used to improve the efficiency of conversion of pulp into paper as well as for paper quality improvement by prevention rubber particle agglomeration. Due to its absorbing property bentonite also offers useful de-inking properties for paper recycling, (Simic*et al*., 2006)

Pharmaceuticals, cosmetics, and spa mud therapy

Bentonite is used as a fitter in pharmaceutical and for its absorption/adsorption functions. It is also employed in creams, face powder, and spa mud preparations, (Simic*et al*., 2006).

1.7 Literature Review

The nanoparticle based on natural bentonite from Pahae village had been prepared using co-precipitation method. Bentonite was dried in the oven at 100ºC during a week. Bentonite is crushed using a mortal and milled by planetary ball mill to obtain the powder form. Further, the bentonite powder is activated with chemical reaction by dissolves the 50 g bentonite to 100 ml of HCl at 10 M. The magnetic stirrer was employed to mix the solution at 300 rpm and temperature 70ºC. After that, the bentonite solution is washed using distilled water until the pH is neutral. The bentonite powder is calcined at temperature of 600oC for 1 hour with fix increment 150ºC. Finally, the powder is given High Energy Milling (HEM) treatment for 30 minutes to obtain the particle size. The X-ray Difractometer (XRD) and Scanning Electron Microscope (SEM) were used to characterize. From the characterization results it is reported that the average of bentonite nanoparticle size is 35.26 nm and the chemical constituents of natural bentonitePahae are Al, Si, Ca, Fe and Ti, (Makmur*et al*, 2017).

Natural clays could be modified by the pillarization method, to form Pillared Clays (PILCs). PILCs have been known as porous materials that can be used for many applications, one of which is catalysis. PILCs are interesting because their structures and textural properties can be controlled by using a metal oxide as the pillar. Different metal oxide used as the pillar causes different properties results of pillared clays. Usually, natural smectite clays/bentonites are used as a raw material. Therefore, a series of bentonite pillared by metal oxides was prepared through pillarization method. Variation of metals pillared into bentonite are aluminium, chromium, zirconium, and ferro. The physicochemical properties of catalysts were characterized by using X-ray Diffraction (XRD), Thermo-Gravimetric Analysis (TGA), Brunauer-Emmett-Teller (BET) and Barret-Joyner-Halenda (BJH) analysis, and Fourier transform infrared spectroscopy (FTIR) measurement. Noteworthy characterization results showed that different metals pillared into bentonite affected physical and chemical properties, i.e. basal spacing, surface area, pore size distribution, thermal stability and acidity, (Nino R and Anis K, 2017).

Based on mineralogical and technological investigations of the deposit "Greda" important characteristics of bentonite clay were determined. Representative samples of the deposit were characterized with X-ray diffraction, low-temperature nitrogen adsorption, chemical analysis, differential thermal analysis and scanning electron microscopy. It was determined that the main mineral is montmorillonite and in subordinate quantities kaolinite, quartz and pyrite. The chemical composition generally shows high silica and alumina contents in all samples and small quantities of Fe^{3+}, Ca^{2+} and Mg^{2+} cations. Based on technological and mineralogical research, bentonite from this deposit is a high-quality raw material for use in the ceramic industry, (Nadezda *et al*, 2011).

A light yellow colored bentonite clay mineral obtained from India was studied. X ray diffraction (XRD) studies suggested that Fe_2O_3, Al_2O_3, quartz and Ca bentonite phases are present in the compound. Ca-bentonite is the major constituent and its unit cell is monoclinic with a=5.16, b=8.798, c=9.347Å and β=100.460. Internal structure studied using Transimission electron microscope (TEM) suggests that the clay consists of iron oxide, aluminium oxide, quartz, Ca bentonite. Tetrahedral and octahedral layers are present. Fe^{3+} is present in the location of Al^{3+} in the unit cell of Ca-bentonite. Electron paramagnetic resonance (EPR) results indicate that the unit cell of the crystal contains Fe(III), and its g values are found to be 4.19 and 2.13. IR studies are indicating that the presence of silicate and hydroxyl anions as ligands. Nonlinear optical measurements are indicating that the compound is having good potential applications in laser safety devices, (Ravindra*et al*., 2017).

Bentoniteclaymineralfromthe Gulbarga region belonging to the smectite group having a wide range of industrial uses was activated by different methods (such as water, chemically and thermally activated). The acid activation of the investigated bentonite increased three times the surface area and volume. This activated clay is characterized for chemical analysis (XRF). Surface area determination indicates increase in surface pore diameter. ThermalGravimetric analysis (TGA) and Differential thermal analysis indicates the decomposition of carbonates. X-ray diffraction (XRD) patterns indicate the increase in the calcium phase, (Sridhar *et al*.,2011).

An empirical model for determining swelling pressure is presented and used for the quantification of the expected sealing properties given the limits concerning buffer density and montmorillonite content. For the reference bentonites MX-80, the stipulated montmorillonite content interval from 0.75 to 0.9 gives a pressure interval from 8 to 11 MPa at the nominal saturated density 2,000 kg/m3. The stipulated saturated density interval from 1,950 to 2,050 kg/m3 gives a pressure range from 6 to 15 MPa at the measured montmorillonite content of 83% by weight. The combined effects of the stipulated montmorillonite content interval and saturated density interval lead to a pressure range from 5 to 17 MPa. If the increasing effect of accessory minerals, which is proposed by the model, is not taken into account then the combined pressure range is 3 to 14 MPa, (Karnland*et al*., 2006).

1.8 Aim and Objectives

The aim of this experiment is preparation and characterization of 20% Fe Al-pillared Interlayer Bentonite clay.

The objectives of the work are;

a) To purify the raw Bentonite sample from quartz and other impurities.

b) To intercalate the Bentonite with Aluminum and Iron metals.

c) To determine the surface area of the pillared Bentonite using BET analysis.

II. Materials and Methods

2.0 Materials

2.1.1 Sampling and sample Pre-treatment

a) Sample

The sample (Calcium Bentonite) used in this research was obtained from market, a product of LobaChemie, Mumbai India, which was purified and then utilized.

Apparatus and equipments

The laboratory equipment and glass wares(routines) were used as instructed by the manufacturer. Apparatus used are listed in table 2.1 below.

Table 2.1 List of equipment used in the research work.

S/N	EQUIPMENT	MODEL	MANUFACTURER
1	Thermostat Oven	DHG-9023A	
2	Centrifugal machine	SM800D	Microfield instrument, England
3	Magnetic stirrer	EYELA-ERC 100H	Tokyo, Japan
4	Ultrasonicator	5L-120/90W	
5	Weighing balance		

Table 2.2 List of reagents and chemicals used.

Reagents	Formula	Purity%	Manufacturer
Aluminium chloride	$AlCl_3.6H_20$	97.0	BDH, England
Sodium hydroxide	NaOH	98.0	BDH, England
Ferric Chloride	$FeCl_3$	98.0	Loba Chemic
Sodium hexametaphosphate	$(NaPO_3)_6$		Kermel, Chain
Pyridine	C_5H_5N	99.5	Kermel, Chain
Silver nitrate	$AgNO_3$		Kermel, Chain

2.2 Methods

2.3 Purification of Bentonite Clay

The raw Bentonite was grinded using a grinder and sieved to greater than 40 mesh size. The grounded Bentonite was then suspended in a distilled water (1g per 12cm^3 of water) containing 0.5g of 1% Sodium hexametaphosphate ($(NaPO_3)_6$) of the Bentonite mass. The suspension was then stirred magnetically for 24 hours in a magnetic stirrer. The Supernatant of the dispersion was then separated with a centrifuge (700rpm in 2 minutes), then the purified Bentonite was recovered after the supernatant was centrifuged (4500rpm in 2 minutes). Then washed four times with distilled water (1g per 12cm^3 of water). The sample recovered was then dried up in an Oven (60ºC for 4 hours). (Gong etal,2016)

2.4 Preparation of Polyoxometalate Ion Solution.

200cm^3 of 0.25 $AlCl_3$ solution was placed in a beaker followed by slow addition of 1M NaOH solution (i.e 100ml of the NaOH) until OH/Metal=2. The solution was mixed at room temperature and then allowed to age over night at 60°C, (Palinco *et al.*, 1997)

Note; the above preparation gives 0.5 meq Al^{3+}/ ml of the solution.

2.5 Preparation of 0.25m Iron Chloride ($FeCl_3$)

1.622g of iron chloride was weighed using a weighing balance, which was then transferred to 250ml beaker and 10ml of distilled water was added and the solution was stirred thoroughly in order to obtain a uniform solution

2.6 Preparation of 1m Sodium Hydroxide (NaOH)

4g of sodium hydroxide was weighed and transferred to 250ml beaker, 100ml of distilled water was added to it, the solution was stirred and the uniform mixture was obtained.

2.7 Preparation of 0.25m Aluminium Chloride ($AlCl_3$)

6g of aluminium chloride was weighted in a weighing balance, then transferred to a 250ml beaker, 190ml of distilled water was added to the solute ($AlCl_3$) and it was stirred gently and uniform solution was made. The resulting solution was allowed to age overnight at 60ºc in an oven, (Palincoetal., 1997)

2.8 Preparation of Pillared Bentonite Clay.

A 5% Bentonite solution was prepared by suspending 5g Bentonite in 100cm^3 of distilled water. The solution was then mixed with the pillaring solution to provide 20 meq of Al^{3+}/ g of the Bentonite, with the relation 40cm^3 of the Al^{3+} solution per gram of Bentonite. This mixture was then placed in an ultrasonic bath (50KHz) at ambient temperature (300K) for 2 minutes.The mixture was then centrifuged (4500rpm for 5 minutes) and washed with water (20ml/g) five times, till the filtrate is free from chloride ions ($AgNO_3$ test). This mixture was then dried in an Oven at 60ºC, and then grinded to greater than 40 mesh size. The final grounded intercalated material was then calcined in a furnace (500ºC for 6 hours). (Katdare et al, 1999).

2.9.1 Nitrogen Adsorption/Desorption

Adsorption-desorption experiment using N_2 was carried out at 77K on sorptomatic 1900 Carlo Erbaporosimeter. Before each measurement the samples was outgassed at 423K and 1.33×10^{-3} Pa for 6 hours. The N_2 isotherm was used to determine the specific surface areas (SA) using the BET equation. The $\dot{\alpha}$-plot method was used to calculate the micropore volume. The starting clay was used as reference material.

2.9.2 X-Ray Diffraction Analysis

The Clay sample was pressed in stainless steel sample holder. X-ray diffraction was recorded using Cu Kα radiation (wavelength λ_1 = 1.54060Å, λ_2 = 1.54443Å, intensity K-A_2 / K-A_1 Ratio 0.50000) on a PW1800 diffractometer which is equipped with a cathode and anode operating at 45kV and 40mA with fine divergence and receiving slit of 4mm irradiated length between 0.040 and $100^{o}(2\Theta)$ at a step size of 0.0260^{o}.

III. Results and Discussions

3.1 Results and Discussion of Purification and Fe/Al-Pillared Clay

In the purification process of bentonite, a purified Bentonite was obtained after the purification with change of color from Brown to Light Brown respectively. This is due to the Quartz present in the raw Bentonite and other chemically unwanted substances. In addition, after the purification the bentonite clay was then pillared with Aluminium followed by dopping with Fe, the result from the dopping indicated that the sample was successfully pillared as it shows a change in appearance of the sample by taking the color of the Iron metal (dark brown).

3.2 Results and Discussion of Bet and Xrd Analysis

3.2.1 Discussion

The Properties of the pillared clay are shown in table 3.1 above, where by the Surface area for the single-point and multi-point was found to be 139.669m^2/g and 208.066m^2/g, Micro-pore volume as 0.074cc/g, Pore width 6.929nm., Langmuir Total surface area 759.109m^2/g, Pore volume 0.057/g. The significance of the intercalation was to effect those properties which were found affected in comparison with (Nino R and Anis K, 2017) constant values for physicochemical of pillared clays prepared by various metal oxides, as a pure bentonite has a Specific surface area of 29.75m^2/g, Pore volume of 0.0065cc/g^2, Pore size of 2.11(Å). For only Aluminum pillared is 198.41 m^2/g as Specific surface area, 0.0103 cc/g^2 as the Pore volume while for the Fe- pillared bentonite as 132.15 m^2/g for the Specific surface area, 0.0407cc/g^2 as its pore volume, which perfectly implies that the dopping of the Fe with Al- pillared clay have increased those properties.

A single-point total pore volume (TPV) was calculated, Pore volume was found from the amount of N_2 adsorbed at a relative pressure of 1.33×10^{-3} Pa Specific pore volume: is the sum of volumes of all pores in one gram of adsorbent, there is many models of pore shape existing: slit-like, ink-bottle, conical, globular etc. Total pore volume and the average pore radius of clay were 0.057 cc/g and 6.929 Ǻ, respectively. As mentioned before, the isotherms of adsorption/desorption of N_2 at 77K on the adsorbents, show that natural clay is of type IV for physisorption of gases according to classification of Brunauer *et al.*, (1940) and IUPAC which show a hysteresis. (This hysteresis is due to the capillary condensation of the nitrogen in the pores causing an adsorption or desorption of the nitrogen at different partial pressures during the filling and empting of the mesopores. The molecular sieving effect is believed to differentiate the entrance of various size gas molecules into narrow spaces (Volzone, 1999) leading to differences in surface areas measured with various size adsorbates.

The XRD spectrum of this sample (Figure 3.1) shows SiO_2 peak with the relative intensity of 100.0% with ^{0}2Theta value of 26.7349 and d-spacing 3.33457(Å), while montrmorillnite peak of 49.16% relative intensity, ^{0}2Theta value of 19.9711 and d-spacing of 4.4460(Å) in the pillared clay. This SiO_2 peaks is due to free quartz in the minerals. But in the activated clays only free quartz peaks can be seen and crystalline clay peaks disappears. This suggests that activation makes clay amorphous.

The composition of this pillared bentonite was summarized in Table 3.2. Among the most contents is montmorillonite. Montmorrilonite is a mineral that contains compounds $Al_2O_34Si.H_2O$, (Wijaya and Rohman, 2008), other minerals contained in the bentonite is Mg and Ca occasionally. Bentonite lattice structures composed of a single plate located between two Al_2O_3 SiO_2 plates. Since the structure is montmorillonite can expand and contract, and have the higher power of water and cation adsorption, Besides that bentonite can also be used as catalyst supports, (Fisli and Haeruddin H, 2002).

Table 3.1 Results of BET Analysis

Parameters	Values obtained
Total Surface area (Single-point)	139.669m^2/g
Total Surface area (Multi-point)	208.066m^2/g
Average Pore width	6.929nm
Langmuir Total Surface area	759.109m^2/g
Pore volume	0.057cc/g
Micro-pore volume	0.074cc/g

3.3 Results of Xrd Analysis

Table 3.2 Minerals observed in XRD result

d-spacing value(Å)	Mineral	Rel. Intensity (%)	Position (^{0}2Th.)
4.44600	Na, Mg, (Al_2O_3)	49.16	19.9711

3.33457	Silicon Oxide	100.0	26.7349

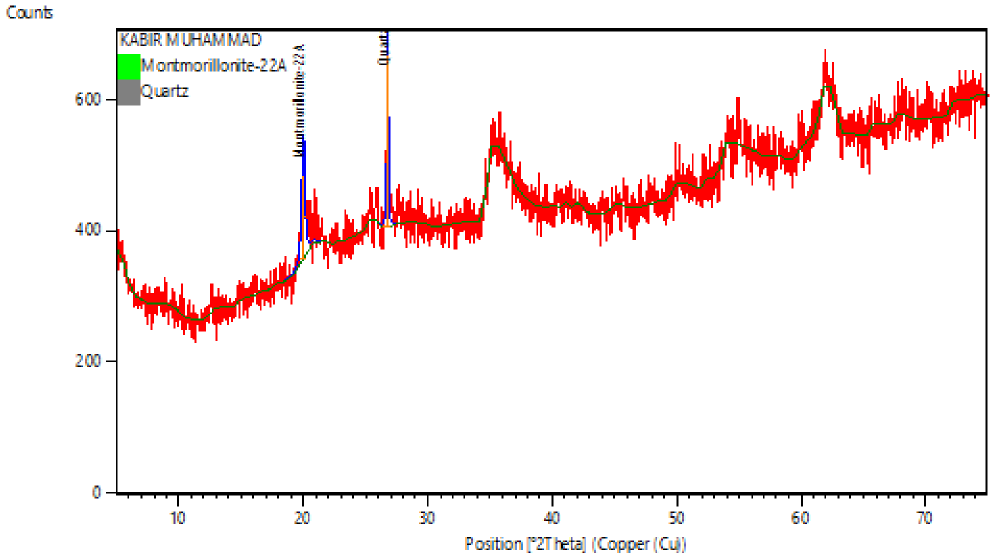


Figure 3.1 XRD result

IV. Conclusion and Recommendation

4.1 Conclusion

In this research analysis as observed a raw bentonite having impurities of quartz and other traces of some unwanted components, was purified and pillared with 20% Fe and Al. The result obtained from BET analysis carried out on this sample was found to be comparatively effective to some parameters like Pore Volume, and even the Micropore Volume, compared to purified and Al-pillared interlayer clay. In the same vein the result from the XRD have shown the presence of Quartz and montmorillonite peak at a relative intensity of 100.0 and 49.16% respectively.

4.2 Recommendation

The analytical technique employed in this research work is workable, though other techniques are also highly prioritize in order to detect many information like XRF analysis that can give a hint of the amount of Quartz removed and the montmorillonite Chemical composition,It is also highly recommended to determine the microstructure by using Scanning Electron Microscopy (SEM) and Fourier Transform IR to elucidate the structural composition like Si-O, Al-OH, TGA etc.

A Research Project Submitted to The Department of Pure and Applied Chemistry, Faculty of Science, Usmanu Danfodiyo University, Sokoto. In Partial Fulfiliment of The Requirements for The Award of Bachelor of Science (Bsc. Honours) Degree in Applied Chemistry.

Dedication

I dedicated this research project to my Parent and all the muslimummah.

Aknowledgement

All praises be to almighty Allah the most merciful, who always under his guidance we find things easy and possible and made our struggles successful and outstanding. May his peace and benediction be upon his most beloved Prophet Muhammad (SAW), his household, companions and all that follow their footsteps up to the day of reckoning.

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Approval Page

This is to certify that this project report by Kabir Mahmud Garba (1510312074) has met the requirements for the award of the Bachelor of Science Degree of the UsmanuDanfodiyo University, Sokoto and is approved for it is contribution to Knowledge.

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Prof. A. B. Muhammad Date

(Project Supervisor)

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Date

(External Examiner)

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Prof. A. B. Muhammad Date

(Head of Department)

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